ance, then the term *"unknown"* should be substituted for it in the regions concerned.

There are many general advantages of a similar character to be gained by the scientist from a slight acquaintance with psychology, and not the least of these is perhaps the more vivid appreciation on his part of the elaborate technique which modern psychology has worked out to meet her needs and the substantial foundation which now underlies modern psychological doctrines. In so enlightened a body of scientists as this which I now have the honor to address, there is undoubtedly no such shallow misconception of the attainments of modern psychology, but there are many who still dwell in the darkness of intellectual night so far as concerns this matter.

I shall select simply a point or two to illustrate the more specific and particular ways in which psychology may contribute to the natural sciences. The contemporary naturalist often has occasion to make use of the psychological principle of association and I would urge on his thoughtful consideration the psychological analyses of this feature of mental life. The bland naiveté with which he often uses this principle makes one gasp who has ever faced its multitudinous complexities. It is a safe surmise that Aristotle had forgotten more about the principle of association than certain modern naturalists have ever known. It is respectfully submitted that it is not good common sense in the use of a principle like this wholly to disregard the elaborate analyses of generations of previous workers. Again, it is out of the question for the neurologist, for instance, studying the function of the auditory end-organ apparatus to go far or safely without a knowledge of such generally unfamiliar phenomena as those of combination tones with their many varieties. Similarly the physiology of the visual processes must remain lamentably incomplete in the hands of an investigator unfamiliar with the important facts of color vision: for example, the peculiarities of such vision under dark and light adaptations respectively, the phenomena of contrast, peripheral retinal color deficiency, the peculiarities of peripheral and foveal space impressions, and so on. In other words, psychology is in a position to furnish a systematized statement of vast ranges of mental phenomena which not only *may* be taken into account by the neurologist, but which *must* be taken into account before his science can approach completion, because these phenomena constitute many of the concrete facts which it is his business to explain. In other words, psychology—or some other science doing her work—sets many of the most important problems for the other biological sciences. Facts which she finds, they must take account of and, if possible, explain.

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SCIENTIFIC BOOKS

The Value of Science. By H. Poincaré, Member of the Institute of France. Authorized Translation with an Introduction, by George Bruce Halsted, Ph.D., F.R.A.S. With a Special Prefatory Essay. Pp. iv + 147. New York, The Science Press. 1907.

In calling attention to M. Poincaré's masterly little book, I propose—these columns being what they are—to consider rather its general significance than to traverse the technical problems of logic and epistemology which it raises. For scientific workers at large, the *tendency* of the monograph happens to be the most important thing about it. It adds another to the numerous contemporary evidences that scientific investigation, when subjected to reflection, and viewed with regard to its methodology and intellectual presuppositions, leads unavoidably to difficulties that belong in the field of philosophy. No doubt, I may incline to exaggerate this view, but, as

I have preached it for years, when another tide was running, I am accumulating no fresh sins on my head, now hoary with them!

Since the days when Lavoisier dethroned phlogiston, Black founded his kitchen-laboratory, Schleiden and Schwann enunciated the cell-theory, Helmholtz published his epoch-making paper on energy, and Pasteur discovered chiralitry, we have been so occupied in the detail of scientific acquisition that little time and, perhaps, less appetite remained for inquiry concerning the fundamental principles in human consciousness whereon all discovery is based ultimately. Doubtless some did philosophize, like Lotze and Mill, and even E. du Bois-Reymond; but in the rush of new and ever new knowledge, they fell upon neglect, or their speculations consorted, in most minds, with other curious diversions. So, fate working with irony as always, many were content to wallow mid most serbonian bogs, hidden away in the recesses of mental construction and, in the eyes of the too few elect, contrived to cut sad antics. The fine futilities of agnosticism, the unashamed, because unconscious, contradictions of materialism, and the mystic improprieties of hylozoism thus came to do duty as presentable accounts of first principles. Anything "went." Every student of the history of culture knows perfectly well that this sort of thing can not go on indefinitely. A day of reckoning has arrived invariably, later if not sooner; and there is no reason to surmise that our own case will furnish any exception to a constant rule. If we would tarry only long enough to ask, for example, the simple question, To what does hypothesis amount? we would, beyond peradventure, rub our eyes when confronted with the unexpected result. It is well, therefore, that a past master in one realm of science should have taken heart of grace to call a halt for the purpose of reviewing some of the fundamental presuppositions incident to all phenomenal research. M. Poincaré's troubles may, indeed, seem far removed from the daily storm and stress of our laboratories. Nevertheless, they can not be dodged if one would know what reliance can be placed upon that elusive thing we label confidently "scientific certainty."

Now, obviously, when normative, and therefore very general, problems come in question, the thinkers who attack them will be influenced, severally, by previous interest, familiarities, and consequent constructive intention. They are helpless to rid themselves of distinctive standpoint. Here, if anywhere, we perceive that the "human" is himself the most important piece of apparatus in the laboratory. We must not expect Poincaré and Ostwald, for instance, to stress identical differences, or even to approach the same issues with similar intent. Nay, even naturalists, like Brooks and Arthur Thomson, diverge widely both in method and outlook, when they record their conclusions on first principles. Naturally, then, M. Poincaré proves this rule —he is always the mathematician, and the mathematician of most "modern port." For this very reason his work proves enthralling, even if some young lions of philosophy could pierce his speculative guard here and there.

Nor is this all. The mathematical spirit comes permeated by gallic genius. Where we, and our kith in the British isles, achieve results by vast compilation of examples, where we are valiantly empirical, the French proceed by way of abstraction and quick appeal to rational principles. Knowledge must fetch and carry for us; for them she is a mistress to be worshipped with a kind of holy joy. Ideas render us restive or impatient, the French would die for a "cause." Hence, as Glazebrook records, in his monograph on Maxwell (pp. 216 f.), Poincaré experiences "a feeling of uneasiness, often even of distrust," in approaching Maxwell's investigations, because "Maxwell does not give a mechanical explanation of electricity and magnetism, he is only concerned to show that such an explanation is possible." The canny Scot was not there to buy out the entire store; he would go in and ask change for sixpence! And he would get it, moreover. But, what is the basis for his procedure? Ignorant of this, his action can not be grasped. The philosophical instinct, with its ineradicable suspicion so intolerable to the eager researcher, speaks

here, and the vital question of legitimacy of method looms up.

M. Poincaré's tendencies in this connection are familiar already to readers of, say, his "Electricité et Optique," or "La Théorie de Lorenz et le Principe de Réaction" (*Arch. néerland.*, ser. 2, v. 5), where his criticism of mechanical constructs ends in the affirmation that, not these, but *unity*, do men really seek. In a word, the empirical references of mechanics must be expressed in mental terms if we would estimate their value for a human experient. The way in which men regard things, the way of thought, calls for consideration just as close as the grasp they may have obtained upon particular objects. In fact, thus the value of alleged grasp must needs be estimated. In a more concrete sense than Grassmann's, and with no necessary reference to prudence, "a doctrine of Forms should precede a doctrine of Magnitude," as H. Hankel pointed out forty years ago. In short, two questions, long subordinated, thanks to preoccupation in special discovery, thrust themselves forward. What basis does scientific thought possess in the sphere of logical reasoning? What value can be assigned to scientific thought in the complexus of human experience? That is to say, M. Poincaré confronts the Sphinx, who asks, What validity, if any, does the scientific view of the universe hold in its own right. And, naturally, his interest being what it is, his achievements being what they are, he presupposes the work of such earlier masters as Riemann and Weierstrass, of such recent scholars as Kronecker, Paul du Bois-Reymond and F. Klein, to say nothing of the remarkable group of his own fellow countrymen. I mean his approach is from this side, not from that of the philosopher *pur sang*. But this matters little, for he has been gifted with a double portion of that Gallic wit which, in our time, stands for Attic salt—the wit to refine ideas of all dross, and to present them crisp from the crucible of thought.

The contrasted, yet complementary, nature of the labors of Riemann and Weierstrass, as noted by M. Poincaré himself (*Acta Math.*, xxii.), serves to hint the general scope of the problem with which he wrestles in this book. "By the instrument of Riemann we see at a glance the general aspect of things—like a traveler who is examining from the peak of a mountain the topography of the plain which he is going to visit, and is finding his bearings. By the instruments of Weierstrass analysis will, in due course, throw light into every corner, and make absolute clearness shine forth." What is this but the age-old puzzle of the universal and the particular? What kind of author have we but one who, being a marvelous analyst, is also an ornament of the school of synthetic mathematics? And we must be prepared to learn, accordingly, that rule of thumb may turn out no rule. A theory may never render a more valuable service to science than when it breaks down, as M. Poincaré has himself said ("La Science et l'Hypothèse," p. 170).

M. Poincaré's conclusions are dominated by considerations like the following: "A reality completely independent of the mind which conceives it, sees or feels it, is an impossibility" (p. 14). "We have not a direct intuition of simultaneity, nor of the equality of two durations. If we think we have this intuition, this is an illusion. We replace it by the aid of certain rules which we apply almost always without taking count of them" (pp. 35–6).

"Space is a mathematical continuum, it is infinite, and we can represent it to ourselves only by physical continua and finite objects. . . . Absolute space is nonsense" (p. 56). "Experience does not prove to us that space has three dimensions; it only proves to us that it is convenient to attribute three to it, because thus the number of fillips is reduced to a minimum" (p. 69). "I believe, therefore, that if by space is understood a mathematical continuum of three dimensions, were it otherwise amorphous, it is the mind which constructs it, but does not construct it out of nothing; it needs materials and models" (p. 72). "The invariant laws are the relations between the crude facts, while the relations between the 'scientific facts' remain always dependent on certain conventions" (p. 128).

"A philosopher really anti-intellectualistic

is impossible" (p. 114). *"All the scientist creates in a fact is the language in which he enunciates it"* (p. 121). "Since the enunciation of our laws may vary with the conventions we adopt, since these conventions may modify even the natural relations of these laws, is there in the manifold of these laws something independent of these conventions and which may, so to speak, play the rôle of the *universal invariant*? . . . In any case a minimum of humanity is necessary" (pp. 127–8). "All classification supposes the active intervention of the classifier" (p. 135). "Sensations are therefore intransmissible, or rather all that is pure quality in them is intransmissible and forever impenetrable. But it is not the same with relations between these sensations" (p. 136). "Nothing is objective except what is identical for all; now we can only speak of such an identity if comparison is possible, and can be translated into a 'money of exchange' capable of transmission from one mind to another. Nothing, therefore, will have objective value except what is transmissible by 'discourse,' that is, intelligible" (p. 137). "All that is not thought is pure nothingness; since we can think only thought and all the words we use to speak of things can express only thoughts, to say there is something other than thought is, therefore, an affirmation which can have no meaning" (p. 142).

It is plain enough, from these representative and characteristic selections, that M. Poincaré has not acquired familiarity with psychological investigation; that, as yet, he has not compelled himself to think through to a definite, coordinated, basis in epistemology; that his logical methods tend to gloss the secondary character of symbolism; and, above all, that he has not clarified the ultimate metaphysical problem immanent in his acute dialectics. But of these limitations, as the professional philosopher will at once see them, I incline to make light. For it is an immense gain that M. Poincaré should have insisted, not merely upon the existence of such riddles, but upon their fundamental import for an evaluation of scientific modes of presentation.

The book ought to be in the hands of all who desire to "mix their colors with brains."

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Atlas of Absorption Spectra. By H. S. UHLER and R. W. WOOD. Carnegie Institution of Washington, Washington, D. C., 1907.

"To furnish graphical representations, on a normal scale of wave-lengths, of the absorption spectra, both in the visible and ultraviolet regions, of a reasonably large number of compounds," is stated by the authors as their chief object in producing this book, and with the exception of the fact that their spectrograms do not extend into the red, their object has been very well attained.

The book opens with a two-page introduction by Professor Wood, which is followed by eighteen pages including descriptions of the apparatus used, spectrograph, sources of light, photographic materials, explanation of the tables, etc. The tables occupy about forty pages, and give, in systematic form, the results obtained for 147 aniline dyes and some of their related organic compounds, and 36 miscellaneous absorbing media, chiefly inorganic salts. Twenty-six plates, 102 figures, positives of the spectra observed, complete the book.

The dispersing apparatus used was a concave grating of 98.3 cm. radius, the ruled surface of which was 1.96 cm. by 5.36 cm. Most of the photographs were taken on celluloid films, sensitized with Seed's "L-ortho" emulsion. A few photographs were taken on Cramer's Trichromatic plates, for the orange and red regions up to about .63 μ. Most of the plates extend from about .20 μ or .22 μ to about .59 μ or .60 μ, where the Seed plates cease to be sensitive for normal exposures.

A Nernst glower carrying .8 ampere on a 104 volt 133 cycle circuit, furnished a continuous spectrum down to about .32 μ or .34 μ. A spark between electrodes, one of sheet brass and the other of equal parts of zinc and cadmium, furnished a bright line spectrum from about .2 μ up. The spark spectrum was cut off from the plate by a movable screen